

ART. XII.—*Monograph on Australian Fossil Polyplacophora
(Chitons).*

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(Communicated by J. A. Kershaw, F.E.S.).

(With Plates XVIII.-XXII.)

[Read 11th December, 1924.]

I am indebted to the National Museum, Melbourne, Victoria, for the present opportunity of examining a number of fossil Polyplacophora, many of which were personally collected by Mr. Frederick Chapman, Palaeontologist to the Museum; to Mr. Francis A. Cudmore, for the loan of many specimens collected by himself, as well as others that had been collected by the late Dr. T. S. Hall; to Mr. F. A. Singleton, for help in many directions, and in particular for supplying the exact localities and horizons; to the University of Adelaide and to the widow of the late Mr. E. D. Atkinson for the loan of many types; and to Prof. Harvey Johnston for loan of literature. It was originally intended to limit this paper to a description of the fossil Polyplacophora in the National Museum, Melbourne, but since it has been possible to assemble the types of all the fossil Chitons hitherto described from Australia, many of which were imperfectly figured, it has seemed desirable to enlarge the scope so that this paper may include all the known species.

Up to the present time sixteen species of fossil Chitons have been described from Australia, all from Victoria and Tasmania. Ashby and Torr described nine in 1901, Hall two in 1905, Hull one in 1910, and three by the same gentleman in 1915, and one by Ashby in 1921. Our knowledge of forms now living in Australian waters has advanced greatly since the earlier papers were written, therefore some revision of earlier work is made desirable.

Class Amphineura.

Order POLYPLACOPHORA, Blainville.

Sub-order EOPLACOPHORA, Pilsbry.

Polyplacophora with the tegmentum coextensive with the articulation, or with the latter projecting in smooth, unslit insertion plates; gills posterior.

Family LEPIDOPLEURIDAE, Pilsbry.

Genus *Lepidopleurus*, Risso.

LEPIDOPLEURUS MAGNOGRANIFER, n. sp.

(Plate XVIII., Fig. 1.)

(Trans. Roy. Soc. S. Austr., vol. xxv., pt. ii., p. 142, 1901.)

Ashby and Torr in the paper (l.c.) gave a brief description of a single median valve under the No. 10, but gave it no name.

Having again carefully examined this valve and compared it with all the known forms living in Australian waters, as well as with many exotic ones, I am satisfied that one is fully justified in describing it and giving it a name. This is the first fossil member of the genus recorded from Australia.

One example of median valve, measuring 5 mm., laterally, and 2 mm., longitudinally.

Dorsal Area.—Is badly eroded, but in one spot there is evidence that this area was longitudinally ribbed.

Pleural Area.—Is decorated with somewhat bowed, longitudinal ribs, which start at the anterior margin of the lateral area, where they are crowded and narrow, but increase in width anteriorly; these ribs, although considerably worn, show pectination.

The evidence is sufficient to lead one to conclude that these longitudinal ribs when well preserved will be found to be composed of closely packed, imbricating, flattened granules, a feature that is so characteristic of the Australian members of this genus. I can count fourteen of these rows, but as before stated there is suggestive evidence that they were continued right over the dorsal area.

Lateral Area.—Differs entirely from any of our Australian forms in that its sculpture is very distinct from that of the rest of the valve. This area is strongly raised and decorated with four, increasing to seven at the girdle, radiating rows of very large, flat, irregular, although more circular than otherwise, granules.

Inside.—Insertion plates absent, sinus broad, sutural laminae small and shallow, tegmentum folded over at the posterior margin, the two lateral callus-portions are exceptionally high and broad.

Remarks.—In the absence of the end valves it is not possible to be certain under which of the genera of the Lepidopleuridae this species should be placed. I have compared it with representatives from my own collection, of the genera *Lepidopleurus*, *Hanleya*, *Oldroydia* and *Hemiarthrum*; it certainly more nearly corresponds with the first named, although the coarse sculpture of the lateral area approaches that of *Oldroydia*, but it does not possess the peculiar frontal extension of the jugal-tract, of that genus.

Locality.—Muddy Creek, Victoria; the particular bed not recorded. Type in Tate Museum, University of Adelaide.

Family PROTOCHITONIDAE, Ashby, n. fam.

Distinguished by the absence of insertion plates in the end valves; the presence of well defined sutural laminae and broad, although incomplete and unslit insertion plates in the median valves; strong granulose sculpture in all valves, the tail valve having a well defined mucro and great extension of the tegmentum posteriorly beyond the callus termination of the articulamentum. Type of Family *Protochiton granulosus*, Ashby and Torr (*Acanthochites granulosus*, Ashby and Torr, Trans. Roy. Soc. S. Austr., vol. xxv., pt. ii., pp. 139-140, pl. iv., fig. 9, 1901). Following Pilsbry in Zittel—his Sub-Order Eoplacophora will now have three families: (1) Gryphochitonidae, (2) Lepidopleuridae, (3) Protochitonidae.

Palaeozoic Chitons.—Pilsbry, in the English Translation of Zittel, by Eastman (vol. I., p. 434, 1900), gives the following classification, placing all the Palaeozoic forms under his new family Gryphochitonidae.

Genus	<i>Helminthochiton</i> , Salter	-	-	Silurian.
	<i>Priscochiton</i> , Billings	-	-	Ordovician.
	<i>Gryphochiton</i> , Gray	-	-	Carboniferous.
	<i>Pterochiton</i> , Cpr.	-	-	"
	<i>Cymatochiton</i> , Dall	-	-	Permian.
	<i>Probolaeum</i> , Cpr.	-	-	Devonian.
	<i>Chonechiton</i> , Cpr.	-	-	Carboniferous.
	<i>Loricites</i> , Cpr.	-	-	"

Pilsbry (Man. Conch., vol. xiv., p. xxiii, 1892), says: "It is commonly known that the earlier (Palaeozoic) Chitons are, without exception, destitute of insertion plates, and belong therefore to the family Lepidopleuridae."

Zittel (Hand. der Palaeontologie, Bd. II., p. 174, 1881-5), after referring to a number of Palaeozoic forms under the comprehensive term "Chiton," says "they are wanting in the Triassic, occur seldom in the Jurassic and Cretaceous, and appear also in the Tertiary deposits, but in few species."

Salter (Q.J.G.S., vol. iii., p. 48, 1847), refers to thirty-two fossil species. His figure of *Helminthochiton priscus* somewhat suggests the sculpture and shape of the frontal half of the shell described hereunder under the name *Protochiton granulosus*, but *priscus* possesses no insertion plate, and the posterior margin is V-shape, very different from *granulosus*.

Pilsbry, in Zittel (l.c. p. 433), says "none of the Palaeozoic genera are known to continue into the Mesozoic, but are replaced by types more related to modern chitons."

Protochiton, n. gen.

Chitons in which the insertion plates of the end valves are absent, the median valves having incomplete, unslit insertion plates.

The articulation is not weak, as in the Lepidopleuridae, but well developed; the valves after the first, are about equal in length and breadth, strongly sculptured with rows of elongate granules; the articulamentum of the tail valve ends in a callus portion beyond which the tegmentum is produced posteriorly for almost quarter of the total length of the tegmentum.

Type.—*Acanthochites granulatus*, Ashby and Torr. (l.c.).

Ashby and Torr in 1901 (l.c.) described this unique form from a median valve only; they pointed out that the insertion plate was unsplit, nevertheless the form and sculpture of the valve determined them to place it under the genus *Acanthochites* [*Acanthochiton*].

Chapman (Proc. Roy. Soc. Vict., vol. xx. (n.s.), pt. ii., pp. 218-220, pl. xviii., Figs. 5, 6, 7, 1907), described and figured the tail valve under the name *Ischnochiton* (*Ischnoplax*) *granulosus*, Ashby and Torr sp., commenting thereon as follows: "This species must be transferred to the genus *Ischnochiton*, occasioned by the discovery of the tail-valve, particularly characterised by a callus-termination of the posterior border of the articulamentum; and to the subgenus *Ischnoplax*, since the shape of the valves indicates a narrow body, with an elevated posterior valve and a posteriorly situated mucro. In view of the fact that *Acanthochites*, subgenus *Notoplax*, is distinguished by the numerous slits in the articulamentum of the tail valve, which latter also projects beyond the tegmentum posteriorly, it is difficult to discern the ground upon which the original authors of this species founded their conclusions as to the genus in which it should be placed, seeing that they record only median valves." Chapman was misled by the subcrenulate callus-termination of the articulamentum of the tail valve, entirely overlooking the fact that the insertion plate was absent, whereas in the family Ischnochitonidae and the genus *Ischnoplax* it is present and slit. The only character that seems common to the two genera *Ischnoplax* and *Protochiton*, is that the valves indicate from their general shape that the animal had a narrow body, which feature is mentioned by Chapman.

Phylogenetic discussion.

The entire absence of insertion plates in the two end valves indicates its primitive origin, and the fact that all the genera of the Lepidopleuridae, other than the genus *Lepidopleurus* s.s., have insertion plates on one or both of the end valves, indicates that its progenitor, if derived through that Phylum at all, branched off at a very early stage of development of the simplest genus in that group. (The possibility of its being derived from earlier Palaeozoic or Mesozoic forms is referred to lower down in this discussion.) On the other hand, with the exception of the one character, i.e., the absence of the insertion in the end valves, it shows little affinity with any of the Lepidopleuridae. The shape of the valve, as long as broad, the well developed sutural laminae,

broad although incomplete insertion plates in the median valves, are certainly suggestive of the Acanthochitonidae, Hedley=Acanthochitidae, Pilsbry. Then we are faced with the fact that members of that family have highly developed slit insertion plates, in the end valves. I have therefore proposed for its reception the generic name *Protochiton*, and the family name *Protochitonidae*. To determine the exact niche in the Natural Taxis that this family should occupy is somewhat difficult.

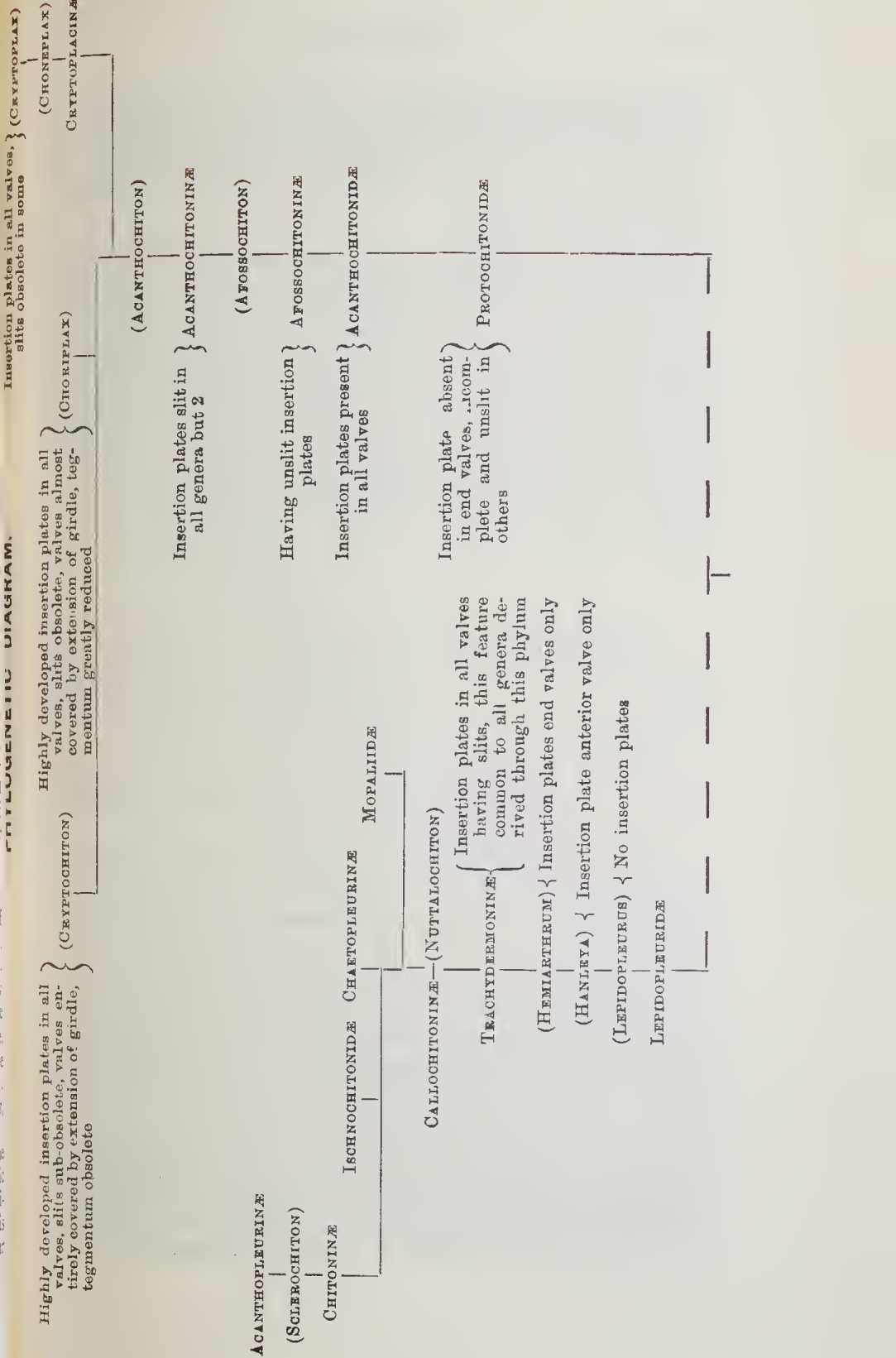
That there is a wide gap separating it from any of the living forms related to the genus *Acanthochiton*, all must admit, but I am confident that sooner or later some fossil form will be discovered intermediate between the two. But we are confronted with a gap no less wide between *Protochiton* and the genus *Lepidopleurus*. While I have suggested that the stock from which the Protochitonidae are derived, branched off just above the most primitive genus of the Lepidopleuridae, the features already pointed out, together with the extraordinary development of the tegmentum of the tail valve, evidence a specialization of no mean order. It appears to me that the girdle was attached by muscle fibres, not only to the callus-termination of the articulamentum, but also to the underside of the whole of the posterior extension of the tegmentum. If we are correct, and I certainly think we are, in assuming that the development of the insertion plates, and, later, their slitting and serration, has slowly been evolved for the purpose of giving stronger attachment for the girdle, and thereby making for the survival of the species; then we must conclude that the peculiar feature under discussion was a specialised development (or experiment, if you will) outwards, forming the posterior insertion plate, with a corresponding shrinkage of the upper shell or tegmentum, as in the genus *Acanthochiton*, this suppression of the upper shell reaching its maximum in the two genera *Choriplax* and *Cryptochiton*.

Phylogenetic Diagram.

It is evident that the Phylum Acanthochitonidae branched off at a much more remote period than has previously been supposed. Thiele, in his Phylogenetic Diagram (Zool., Heft 56, pt. ii., p. 117), branches his Phylum Acanthochitidae immediately below the branch Mopaliidae, considering that both these families are derived from more primitive stock than the Chaetopleurinae, Ischnochitonidae, or Chitonidae. In my classification I derive the Phylum Acanthochitonidae from much more primitive stock still, branching it off from immediately above the genus *Lepidopleurus*, the most primitive genus of all living chitons.

I cannot but think that even this treatment falls short of the truth, and that it is really derived from Mesozoic or Palaeozoic forms, along parallel lines to those of the progenitors of the Lepidopleuridae. I show this in my Phylogenetic Diagram. If this can be determined, it introduces important modifications to our present classification.

PHYLOGENETIC DIAGRAM.



The earlier writers on Palaeozoic Chitons have largely ignored taxonomic features, often finding relationships on purely superficial likenesses. Neither the descriptions nor the figures furnish the evidence one seeks. Pilsbry, as before quoted, suggests that continuity is broken in the Mesozoic period, Chitons again recurring in the Tertiary.

The thought is forced upon one that it is possible that these missing links in the chain of sequence may have survived much longer in these Australian seas than has been the case in other parts of the world. I look forward for new discoveries to demonstrate that at least the Acanthochitons have been derived not through the Lepidopleuridae, but direct from Palaeozoic stock. The data available in various palaeontological works suggest that even in Palaeozoic times very diverse forms were already in existence, and considerable specialization in certain directions had already taken place. Most of them seem to have had narrow bodies, in this respect corresponding with the species under review, rather than with the members of the genus *Lepidopleurus*.

PROTOCHITON GRANULOSUS, (Ashby and Torr).

(Plate XVIII., Figs. 2, 3, 4, 5a,b.)

(*Acanthochites granulosis*, Ashby and Torr, Trans. Roy. Soc. S. Austr., vol. xxv., pt. ii., pp. 139-140, pl. iv., fig. 9, 1901; *Ischnochiton (Ischnoplax) granulosis*, of Chapman, Proc. Roy. Soc. Vict., vol. xx. (n.s.), pt. ii., pp. 218-220, pl. xviii., figs. 5, 6, 7, 1907.)

Type Description.—“Two examples of median valves.

“General Appearance.—Carinated beaked, side slope straight, except lateral area, which is reflex; color mottled in two shades of green, somewhat bleached.

“Dorsal Area.—This area is clearly defined, being broadly wedge shape, produced forward in a distinct beak, which is slightly bent downwards. A shallow depression separates this area from the pleural. Sculpture consists of about a score of longitudinal, closely packed granulate riblets. The granules increase in definition towards the margin of the pleural area, where they will be more correctly described as longitudinal rows of granules.

“Pleural Area.—In this area the rows of granules are radial, the rows being separated, widely apart, and very regular. In this area the granules become large, digitate, in some cases pointed, inclined very much forward, the apex of one just reaching to the base of the one in front of it. Where the apex is broken off the pustules are seen to be hollow.

“Lateral Area.—Raised or recurved, clearly defined, the pustules being rounded and granulate, becoming crowded and irregularly placed as they approach the posterior margin of valve.

“Inside.—The articulamentum was probably white. The insertion plates are well produced, though in the specimens under

examination rather broken, and apparently unsplit. The upper surface of the sutural laminae is irregularly grooved, sinus broad.

"Measurement.—Width of valve, 7 mm.; length of valve, 7 mm.; length of slope, 5 mm.; divergence, 100°.

"Locality.—Schnapper Point."

There is but little to add to the foregoing description of the type median valve, except that the granulose ribs in the dorsal area are intercalated, almost doubling the number of rows named at the anterior margin.

The specimen before me from the same beds was collected by Mr. Francis Cudmore, and measures 9.5 mm. longitudinally and 11 mm. laterally. The production of the sutural laminae and incomplete insertion plate, is quite perfect, the former project in front of the tegmentum 2 mm., and the insertion plate is continued at full width to within $1\frac{1}{2}$ mm. of the posterior margin of the tegmentum, when it turns abruptly inwards, apparently at the exact point where the slit is developed in the genus *Acanthochiton*; from here the insertion is continued in a very shallow wedge-shaped extension almost to the posterior margin of the tegmentum. The cavcs are well defined.

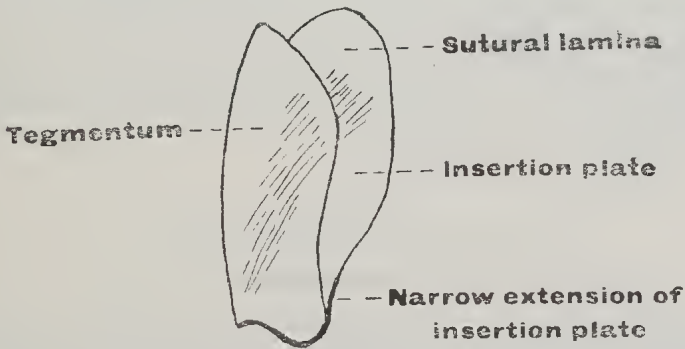


FIG. 1.—Median valve of *Protochiton granulosis*, (Ashby and Torr).

Tail Valve.—The dorsal area is similar to that of the median valve, the mucro is post-median, deep and dropping abruptly to the flat posterior half of valve; the pleural area is similar in its decoration to the same area in the median valves, and is separated from the posterior portion of valve by a shallow, diagonal trough, produced forward; the posterior half of valve is flat to concave, the posterior third being recurved. Chapman (l.c.), in his description of this portion of the valve says, "Area behind mucro, plane, undulate or slightly concave, ornamented with numerous small pustules arranged in a rather obscurely quincuncial pattern. The outer borders of the pustules each carry a pigmented centre, slightly depressed, showing the presence of rudimentary eyes."

I would add that these granules are elongate, although more circular than is the case in the other areas. Under 65 mag. the central depressions referred to by Chapman, are seen to be longitudinal, with minute, irregularly placed micropores, in these depressions. While I have no doubt that these pores were the terminals to nerve fibres, I doubt whether they had in this shell been transformed into "eyes." Similar micropores are present, although less numerous in the median valves.

Inside.—White, smooth under dorsal area, from there deep grooves and ridges radiate outwards, half across the shell.

Anterior Valve.—Mr. Cudmore has been successful in collecting the anterior valve, which has not before been found, and is a valued addition to our knowledge of this interesting species. This valve measures longitudinally 4.5 mm., and laterally 7 mm., the anterior margin of the tegmentum reaches almost 0.5 mm. beyond the articulamentum, the valve is raised and decorated with about 60 radiating rows of packed, although separated, elliptical granules, which are very minute near the apex, and increase in size towards the margin. The rows in spite of being so crowded are well defined, except near the posterior margin; there the granules are a little confused and less elliptical. The inside is white, the articulamentum terminating anteriorly in a callus portion, the anterior third of the inside is much grooved, the tegmentum overlaps the posterior margin.

Localities.—Balcombe Bay; and one valve from Grice's Creek, Victoria (F. Cudmore coll.); also not uncommon at Clifton Bank, Muddy Creek.

Age.—Oligocene (Balcombian).

Sub-order CHITONINA, Thiele.

Family ACANTHOCHITONIDAE, Hedley.

Family Acanthochitonidae, Hedley¹, replaces Cryptoplacidae, Dall, and Acanthochitidae, Pilsbry; also the sub-family Acanthochitoninae, Ashby, replaces the sub-family Acanthochitinae, Thiele.

Thiele (Rev. des Syst. der Chit., p. 116, 1910) places the Acanthochitidae and Cryptoplacidae in one family, in which I concur. Iredale (Proc. Mal. Soc. Lond., vol. xi., pp. 34 and 126-7, 1914; Trans. N.Zd. Inst., vol. 47, p. 422, 1915), also concurs with Thiele in this, but substitutes the new family name Cryptoconchidae, founding it on the genus *Cryptoconchus*, which dates from Burrow's note of 1815 and, therefore, antedates *Acanthochiton*, Gray, 1821. I myself accepted Iredale's dictum both in a published paper and in MSS., expressing regret that owing to the law of priority the name of the typical genus *Acanthochiton* should be lost as a

1. Hedley in Index Moll. of West Austr.; Jour. Roy. Soc. West Austr., vol. i., p. 24, 1916, uses "Family Acanthochitonidae"; also W. H. Dall in List U.S. Nat. Mus. Bull. 112, p. 197, 1921, uses the same family name.

family name. Several of my friends have kindly pointed out to me that that law does not apply to ordinal or family names, the word "type-genus" in Article 4 (International Rules) meaning "typical genus."

The genus *Acanthochitona*, Gray, in "London Medical Repository," vol. xv., p. 234, 1821, antedates *Acanthochites*, Risso, 1826. Iredale, l.c., p. 422, emended the terminal *a* thus, *Acanthochiton*, Gray, 1821, em. Odhner and myself have followed him in this, for there are a good many precedents, and under Article 19 (Int. Rul.), "an error of transcription" may be amended. At this late date it will be impossible to prove that this unfortunate terminal *a* was due to such an error, but it will be equally impossible to prove to the contrary. My friend, S. S. Berry, of California, expressed the feelings of all, I think, when he wrote me, "I would be as pleased to get rid of that final *a* as yourself."

I consider the rule quoted supplies a loop-hole and the common-sense course is to take it. A decision approving this might well be adopted at the next International Congress. Article 5 states that the name of a family or sub-family is to be changed when the type genus is changed. As the names *Acanthochitidae*, Pilsbry and *Acanthochitinae*, Thiele are both founded on *Acanthochites*, Risso the adoption of the earlier generic name *Acanthochitona*, or as emended, *Acanthochiton*, Gray gives us the family *Acanthochitonidae*, and sub-family *Acanthochitoninae*. As these are not amendments, but new names, one is regretfully unable to attach the names of Pilsbry and Thiele as authors.

Sub-family AFOSSOCHITONINAE, Ashby, n. sub-fam.

(Unslit insertion plates).

Afossochiton, n. gen.

Having median valves similar in sculpture and general shape to members of the genus *Acanthochiton*, but in which the insertion plate is narrower, and having neither slit nor suture present, the slit in the *Acanthochitons* is usually short, but is continued to the tegmentum in a deep channel or suture. Both slit and suture are absent in members of this genus, whereas they are both present in members of the subfamily *Acanthochitoninae*; on this account this genus must precede that subfamily, being a closely related but more primitive form. I cite *Afossochiton cudmorei*, Ashby, as type of this new genus.

AFOSSOCHITON CUDMOREI, n. sp.

(Plate XVIII., Figs. 6, 7.)

Among the specimens sent me for examination by Mr. Francis Cudmore are two median valves of a new species, which I at first intended to include under the genus *Acanthochiton*. In the

collection in the Tate Museum, University of Adelaide, is another similar valve, though not as well preserved, collected at the same locality more than twenty-five years ago, I have pleasure in naming this species after Mr. Cudmore, to whose energetic collecting we are indebted for the opportunity of determining the characters of these fossil chitons.

Specimen No. 1, Holotype.—This is the smaller of the two specimens, which are both median valves, but this one is in the best state of preservation; it measures 4 mm. longitudinally and 6 mm. laterally. Shell carinated, jugum is worn and in present condition rounded, side slope is straight from the margin of dorsal area to the outer edge of shell; the dorsal area is wedge-shaped, beaked and regularly pinnatifid, the toothed margin of this area consists of five well defined teeth on either side, the central portion of this area is too eroded to determine the sculpture.

Lateral Area.—Is narrow and raised, separated from the pleural area by a diagonal, rather abrupt fold. Both the pleural and lateral areas are decorated with nine or ten rows of wedge-shaped, raised granules, each granule is a perfect isosceles triangle, with the base upwards and the apex outwards. The rows of granules commence at the posterior margin, are a little confused in the lateral area, but are very regular in the pleural area. The rows run on the diagonal, and the granules are placed diagonally in the rows. The rows commencing near the beak have very small granules to start with, which rapidly increase in size towards the outer margin, the granules in the lateral area in addition to being in less well defined rows, are larger, and also increase in size towards the insertion plate.

Inside.—The sutural laminae have been broken off, the insertion plates are fairly broad, but not so much so, as in the genus *Acanthochiton* the margin is damaged and unsplit, the tegmentum is infolded under the beak for a short distance (laterally), there are two strongly raised callus portions diverging from the apex, forming a deep V-shaped hollow between them.

Holotype in Nat. Mus. Coll. [13311], pres. F. A. Cudmore.

Specimen No. 2, Paratype.—This also is a median valve, and measures 4 mm. longitudinally, and 7 mm. laterally. The valve is similar in shape to the type, except that there is a well defined trough, commencing below the beak and running parallel with the margin of the dorsal area; from this trough the side slope is less steep than the type, the sculpture is similar where not eroded. One insertion plate is complete, unsplit and without the transverse sinus that accompanies the slit in the genus *Acanthochiton*. The sutural laminae are missing.

Specimen No. 3, Paratype.—This also is a medium valve, measuring longitudinally 5.5 mm., and laterally 9 mm., while the valve surface is less well preserved than the other two, the insertion plates are both fairly complete, and the sutural laminae are present, and produced forward, the sinus between being wide. The peculiar wedge-shape sculpture is present only in a limited

degree. The specimen is the *Acanthochiton*, No. 18, mentioned in Ashby and Torr's paper of 1901 (l.c.). It was then considered too poor a specimen to describe and name.

Locality.—Clifton Bank, Muddy Creek, near Hamilton, Victoria.

Age.—Oligocene (Balcombian).

AFOSSOCHITON ROSTRATUS, (Ashby and Torr).

(Plate XVIII., Fig. 8.)

(*Acanthochites rostratus*, Ashby and Torr, Trans. Roy. Soc. S. Austr., vol. xxv., pt. ii., p. 140, pl. iv., fig. 5, 1901.)

Type description.—"One median valve.

"General Appearance.—Carinated, side slope straight, strongly beaked. Color porcelain white.

"Dorsal Area.—Wedge shape, much raised, convex, strongly beaked, the beak bent downwards. This area is smooth and glossy under an ordinary pocket lens, but under a fairly high power it is seen to be pitted with irregular shallow pitting, highly polished.

"Lateral and Pleural Areas.—These areas are hardly separable. The shell is a little thickened, and the sculpture a little coarser in the lateral area. The ornamentation consists of a number of somewhat irregular longitudinal rows of finger-shaped flattened pustules. The pustules are set diagonally in the rows, and increase to double the size as they reach the margin of the shell. The posterior margin of valve is bent downwards.

"Measurement.—Longitudinally, 3 mm.; breadth, 5 mm.; divergence, 105°.

"Inside.—White, insertion plates and sutural laminae not large, sinus broad and shallow, only indicated by a slight sinuosity of outline.

"Locality.—Schnapper Point."

The only addition needed is, that the tegmentum is folded over under the beak with a peculiar twist in the fold, and the fact that the insertion plates are unsplit, and the sinus which accompanies the slit, is absent as well.

Locality.—Balcombe Bay, Victoria.

Age.—Oligocene (Balcombian).

Note.—While at first I intended placing the foregoing two species under the sub-family *Cryptoconchinae*, close to the genus *Acanthochiton*, one soon realised that unless one assumed that they were representatives of a more specialized genus, in which the slits had become obsolete—a view that seems quite unsupported by any evidence to be obtained from the three median valves—then they are most certainly a primitive type allied to the above-named sub-family. As this assumption is entirely based on the evidence of the median valves alone, their true position in

the Natural Taxis cannot be determined until the end valves are discovered, for although I do not expect it, these valves may be without insertion plates, in which case they will need to be placed under the Protochitonidae. My own opinion is that the species when the full data is available will be found to be nearer the family under which I have provisionally placed them, than to the still more primitive Protochitonidae.

Sub-family ACANTHOCHITONINAE, Ashby.

Genus *Acanthochiton*, Gray, em.

ACANTHOCHITON CHAPMANI, n. sp.

(Plate XVIII., Fig. 9.)

A considerably damaged median valve, of what is apparently a member of the genus *Acanthochiton*, was collected by Mr. Frederick Chapman, at Clifton Bank. In addition to being a good deal worn and the posterior margin weathered, the insertion plates and sutural laminae are either absent or too broken to describe. Still the characters that remain seem sufficiently distinctive to warrant one in giving it a name, and I have much pleasure in calling it after the discoverer.

Description.—Median valve, incomplete, measuring 6 mm. longitudinally, and 7 mm. laterally; carinated, elevated and strongly beaked, posterior margin of valve slants rapidly forward from the beak, the decoration is composed of large, squamose granules, but the most striking feature is an exceptionally raised and coarse diagonal rib; the dorsal area is well defined and arched longitudinally.

Holotype in Nat. Mus. Coll. [13312], pres. F. Chapman.

Locality.—Clifton Bank, Muddy Creek, Victoria.

Age.—Oligocene (Balcombian).

Note.—In the absence of the end valves, and very imperfect sutural laminae and insertion plates, I have provisionally placed it under the above genus, trusting that at no distant date better specimens will be discovered when more accurate determination of its features will be possible.

Sub-family CRYPTOPLACINAE, Thiele.

Genus *Cryptoplax*, Blainville.

In 1905 some interesting fossil valves were described by T. S. Hall, under the names *Cryptoplax pritchardi* and *gatliffi*. Through the kindness of Messrs. Chapman and Cudmore I have been able to examine all the specimens collected by themselves, and also those collected by the late T. S. Hall—in all fully 50 specimens.

They range in length from 3.5 mm. to 11 mm.; all, with one exception, if really *Cryptoplax* valves, are median valves. The one exception is deeply and closely grooved on the inside, the

fluting between the grooves ends in perforations, which suggests that when perfect it was serrate or comb-like at the edge—certainly not a *Cryptoplax* valve. There is not the least suggestion in any of the 50 valves, of the existence of the tegmentum or upper, sculptured layer of shell. In addition to all the species of *Cryptoplax* recorded, as found in Australia, I have examined those from Japan, the Pacific Islands and Madagascar. In every case, however eroded the specimen, the tegmentum exists at the outer margin of the valves and where protected by the girdle. *C. larvaeformis*, (Blainv.) Burrow, from Tonga, does show valves with a polished surface on those portions of the shell from which the tegmentum has been eroded, but some part of the tegmentum is present at the sides of all valves.

Mere frictional erosion will not account for the condition of these 50 fossil valves. As far as I can see the only hypothesis that could account for the entire absence of the tegmentum is that some chemical action has taken place which was able to destroy the upper layer only, leaving the articulamentum intact. Or are they representatives of some extinct genus in which the tegmentum had become obsolete as in the genus *Cryptochiton*?

I have disarticulated living Echini, but their teeth and teeth sheath (alveolus) do not correspond, neither do parts of Sessile Barnacles (Cirripedia) furnish any solution; also the possibility of some member of the Fissurellidae throwing light on the subject has suggested itself. All this evidence is negative; we may hope that the collecting of new material will furnish evidence of a more positive nature.

CRYPTOPLAX PRITCHARDI, Hall.

(Plate XVIII., Figs. 11, 12; Pl. XIX., Figs. 13, 14, 15, 16.)

(Proc. Roy. Soc. Vict., n.s., vol. xvii., pt. ii., pp. 391-2, pl. xxx, figs. 1-6, 1905.)

Type Description.—"All the specimens of the valves that I have found—thirty in number—are much worn, and are polished by attrition, like so many of the fossils in the Kalimnan of Muddy Creek, and in very few cases is the articulamentum [read tegmentum] distinctly shown. The valves approach those of *C. gunni* very closely in shape; indeed, were shape all that we had to guide us, there would be little justification in separating the fossil from it. In a few cases, however, traces of the sculpture of the tegmentum are preserved, and this enables differences of specific value to be pointed out. In *C. gunni* the coarse grooving radiates from the apex, whereas in the present species faint traces of coarse concentric sculpture are visible. In this point *C. pritchardi* makes an approach to *C. larvaeformis*, as figured by Pilsbry. Valve VIII. (see Figs. 3 and 4), allowing for its worn condition, is almost identical in shape with that of *C. gunni*, the posterior insertion plate being vertical.

Median length of specimen shown in Figs. 1 and 2, 7.5 mm.; breadth, 2.5 mm. Median length of original of Figs. 3 and 4, 6.6 mm.; breadth, 2.5 mm.; depth, 1.6 mm. Length of original of Figs. 5 and 6, 4 mm.; breadth, 4 mm.

Locality.—McDonald's, Muddy Creek. Kalimnan (?Miocene²). Thirty examples."

CRYPTOPLAX GATLIFFI, Hall.

(Plate XVIII., Figs. 10*a*,*b*).

(*l.c.* pp. 392-3, pl. xxx., figs. 7-9.)

Type Description.—"Only a single valve has as yet come under my observation, and this is imperfect anteriorly. The articulation is shown on both sides. In shape it differs from any of the valves of *C. pritchardi*, being less pointed posteriorly. The posterior end is produced downwards into a slight hook-like process, which is shown in side view in Fig. 8. Viewed from below this process is crescentic, as it follows the curve of the valve, and its lower surface is flat. This feature, though absent from the recent species and from *C. pritchardi*, occurs in some of the other genera of Polyplacophora.

"The tegmentum is smooth, being abraded, but traces of a median ridge are traceable, the shell in this region being irregularly and finely pitted. Median length of valve (imperfect), 3.7 mm.; breadth, 1.9 mm.

"Locality.—Clifton Bank, Muddy Creek. Balcombian (?Eocene³). A single valve."

I have transcribed above Hall's original descriptions of his two species. Since writing my foreword I have again gone carefully through the whole of the material, and I find that while none of the examples seem true end valves of a *Cryptoplax*, there is certainly a very wide divergence in shape. Some are blunt ended and thick, others are pointed and fragile; under the apex of most is a narrow central ridge, some are bent down at the apex and one shows the thickened process under the apex, which led Hall to describe his second species, *C. gatliffi*, in other respects the two forms seem identical. If the impression I have had ever since I first saw these strange, so-called valves, that they are not portions of the coat of mail of a *Chiton*, is correct, then I think it not unlikely that this little process under the apex may be the clue to the solution. The valves vary also from narrow and straight-sided to broadly wedge-shaped, and in some cases spatulate; a few show compression or incurving laterally.

The concentric ridges which are described by Hall as being visible in some examples, hardly I think correspond with the

2. Regarded in the present paper as Lower Pliocene.

3. Here regarded as Oligocene.

sculpture that is common to members of the genus *Cryptoplax*. The ridges in the specimens under review, start from the base of the smooth dorsal area, and are bowed towards the apex. While I cannot feel satisfied that these interesting little objects are *Cryptoplax* valves, I must admit that up till the present one has absolutely failed to demonstrate that they are something else. May not the polished surface which is so marked in the most perfect specimens be the result of some enveloping mantle, and not due to attrition, as suggested by Hall?

Addenda.—Since writing the foregoing, Hall's original types have been sent to me, and photographs appear in the plate attached to this paper. Two additional features are exhibited in these specimens; one of the cotypes of *C. pritchardi* has no apex, but what in other examples is the apical end is in that turned over like the inside of the heel end of a slipper (is figured sideways in plate). Then the holotype of *C. gatliffi* differs in one respect only, from the majority of the specimens described as *C. pritchardi*, in that it possesses a lobe-shape plate on the inside, just under the apex. This plate will probably furnish a clue to the true character of these structures.

This plate suggests either a bearing or grinding plate, and may possibly have originally been present in the valves of *pritchardi* as well. I admit that the existence of these two features confirms me in the belief in their non-chitonoid origin. The plate evidently filled some purpose that would be inapplicable to the valves of a Chiton.

Family MOPALIIDAE, Pilsbry.

Genus *Plaxiphora*, Gray.

PLAXIPHORA CONCENTRICA, Ashby and Torr.

(Plate XIX., Fig. 18.)

(*l.c.* pp. 138-9, pl. iv., fig. 8.)

Type Description.—"One example of posterior valve only.

"General Appearance.—Broad, rounded. Color pale-brown, slightly olivaceous. The tegmentum is posteriorly bent over, and continued for some distance on the underside of shell. Mucro evidently postmedian, though much worn. The anterior portion of shell well preserved, showing six strong concentric ribs, each following closely the contour of the margin of the shell. There are evidences that these ribs were continued without any break right round the posterior margin, though the ribbing in this part of shell is less strong, and the ribs are closer together. No other sculpture is discernible on the tegmentum. Insertion plates unslit in the posterior valve.

"Measurement.—Posterior valve, total width 17 mm., total length, 10 mm.; width of tegmentum only, 15 mm.; length of tegmentum only, 7 mm.

"Inside.—Articulamentum white, sinus 4 mm. wide at apex, 8 mm. at widest part. Sutural laminae produced beyond the tegmentum, $4\frac{1}{2}$ mm. The sutural laminae and insertion plates are remarkably posteriorly thickened. The two dorsal pits and lateral grooves are very deep.

"Remarks.—This shell is allied to the living forms *Plaxiphora petholata*, Sby., and *P. glauca*, Q. and G., rather more so to the latter than to the former. It is more strongly concentrically ribbed, more evenly rounded, sinus narrower, sutural laminae twice the length, the anterior margin of tegmentum slightly produced forward in the centre of the sinus, and the inside is white instead of greenish-blue. The microscopic vermiculate wrinkling is quite absent in the specimen under description."

Locality.—Gellibrand, Victoria.

Age.—Probably Miocene (Janjukian).

PLAXIPHORA GELLIBRANDI, Ashby and Torr.

(*l.c.* p. 139, pl. iv., fig. 1.)

Type Description.—"One example of posterior valve.

"General Appearance.—Broad, flat, jugum slightly raised, side slope nearly straight. Color blackish, with irregular streaks of green. A pale broad wedge-shaped mark on dorsal ridge.

"Mucro.—Post median, slightly raised.

"Dorsal Area.—Slightly raised and ornamented with a broad whitish wedge-shape mark. A shallow curved diagonal rib runs from the mucro forward, keeping near the margin of valve. The whole of the valve is ornamented with the same peculiar sculpture that is present in *Plaxiphora petholata*, Sby., and which Sowerby in his description describes as a microscopic pattern resembling a dense punctulation, united with a minute zig-zag or vermiculate wrinkling.

"Measurement.—Posterior valve, total width, 14 mm.; total length, 8 mm.; width of tegmentum only, 11 mm.; length of tegmentum only, 5 mm.

"Inside.—Articulamentum white, sinus 3 mm. at apex, increasing to 6 mm.; sutural laminae produced beyond tegmentum 3 mm. The eves [*sic*] are shallow and spongy. The articulamentum of insertion plates and sutural laminae is greatly thickened. The two dorsal pits and corresponding lateral grooves are very deep.

"Locality.—Eocene⁴ beds, Gellibrand, Victoria.

"Remarks.—This species very closely resembles *P. petholata*, Sby. The inside pits and lateral grooves are deeper, and the inside color white instead of greenish blue. The shell is also broader, and the anterior margin of tegmentum is slightly produced forward."

4. Probably Miocene (Janjukian).

Note.—The foregoing two members of the genus *Plaxiphora* are so close to the very variable living form that I think at most they can only rank as sub-species. When more material is available something more definite may be determined; *gellibrandi* certainly looks like a recent shell, and may have slipped into the collection by mistake. In the remarks read *P. alba*, Blainville, for *petholata*, and *P. tasmanica*, Thiele, for *glauca*. In faint writing on box containing type of *P. concentrica* are the words, "I have put in a specimen for compare." I should prefer to retain only the name *P. concentrica* for fossil species; believing that the valve described under the name *gellibrandi* is the valve that had been put into the box containing *concentrica* for comparison. I have followed Thiele (*Zoologica*, p. 117, l.c.) in placing the family Mopaliidae earlier than the family Ischnochitonidae.

Family ISCHNOCHITONIDAE, Pilsbry.

Sub-family CALLISTOPLACINAE, Pilsbry.

Genus *Callistochiton*, Carpenter.

CALLISTOCHITON MERIDIONALIS, Ashby.

(Plate XIX., Fig. 19.)

(Trans. Roy. Soc. S. Austr., vol. xliii., p. 400, 1919.)

The credit is due to Mr. Chapman for having collected the first recorded fossil *Callistochiton* in Australia. He collected one median valve only at Forsyth's, Grange Burn, and a portion of a median valve at MacDonald's, Muddy Creek (upper beds). It is rather worn, the sutural laminae are missing, and the central part of the anterior margin of valve has broken away, but the sculpture is sufficiently preserved to enable one to form the opinion that it is conspecific with the living form described under the above name. The longitudinal ribs agree more closely with *meridionalis*, Ashby, than with *antiquus*, Rve.

Holotype in Nat. Mus. Coll. [13319], pres. F. Chapman.

Locality.—Forsyth's, Grange Burn, and MacDonald's, Muddy Creek, Victoria.

Age.—Lower Pliocene (Kalimnan).

Family CHITONIDAE, Pilsbry.

Sub-family CHITONINAE, Pilsbry.

Genus *Chiton*, Linne.

Sub-genus *Rhyssoplax*, Thiele.

The genus *Rhyssoplax* was founded by Thiele on the characters of the radula of *Chiton affinis*, Issel, from the Gulf of Suez. The specimen examined by Thiele was wrongly labelled *Chiton jancir-*

ensis, Gray. Thiele in his later work dropped the name *Rhyssoplax* in favour of *Clathropleura*, Tiberi; the specimen Thiele examined under this generic name was labelled *C. sicula*, Gray, whereas its correct name was *Chiton olivaceus*, Spengler, a common Mediterranean species. Pilsbry, in his Monograph, vol. xv., p. 67, 1893, shows that the specimen upon which the genus *Clathropleura* was founded by Tiberi, was a *Callochiton*. Iredale in Proc. Mal. Soc., vol. xi., p. 40, 1914, discusses this position, and says, "I here designate *Ch. laevis* (Pennant) Tiberi, as type of *Clathropleura*." Iredale evidently had quite overlooked the fact that Pilsbry had pointed out this position as long ago as 1893. Iredale in the same discussion proposes to include the Australian and New Zealand Chitons under Thiele's subgenus *Rhyssoplax* which was founded upon a European species.

We have this position: Thiele in Gebiss der Schnecken, pp. 267-8, 1893, proposed two generic names for two closely allied species; in his Revision des Systems der Chitonen, pt. ii., p. 117, 1910, he drops *Rhyssoplax* in favour of *Clathropleura*, giving it sub-generic value only; Pilsbry had already shown that Tiberi's name was not available, and Iredale, as before quoted, revives Thiele's name *Rhyssoplax* to replace the name used by Thiele, for a sub-genus of the genus *Chiton*, and proposed that it should be given full generic rank, but neither he nor any workers that have followed him, including the writer, have, as far as I am aware, published any results of an examination of the internal parts of this group of Australasian Chitons, and nothing has been advanced in support of the elevation of *Rhyssoplax* into full generic rank. I consider that it should, until more thorough work is done, be considered a sub-genus of the genus *Chiton*. Although superficially the southern forms from Australia seem congeneric with the northern European ones referred to, a more thorough study may not unlikely yet lead to their separation.

CHITON (RHYSSOPLAX) FOSSICIUS, Ashby and Torr.

(Plate XIX., Fig. 21.)

(Trans. Roy Soc. S. Austr., vol. xxv., pt. ii., pp. 140-1, pl. 4, Fig. 4, 1901.)

Type Description.—"One example median valve.

"General Appearance.—Valve narrow, carinated, side slopes nearly straight. Color pale olivaceous buff.

"Lateral Area.—This area is separated from the pleural area by a much raised, broad, diagonal rib. This rib occupies fully one-half of the area; on the other half are two shallow radial ribs.

"Pleural Area.—This area appears to have been sculptured right up to the dorsal ridge, with about 13 sharply chiselled, imbricating longitudinal ribs. The sutures between the ribs are deeply cut, and end as they reach the raised diagonal rib of the lateral

area in a very deep pit. So deep are these pits that with the naked eye they appear to be perforations through the tegmentum.

"Dorsal Area.—This area is much worn, but, as before stated, there are indications that the ribbing of the pleural area was continued right over this area. The valve is slightly beaked, which is smooth, no striae being discernible.

"Measurement.—Greatest width between the slopes, 10 mm.; greatest width of slope, 4 mm.; length of slope, 7 mm.; divergence, 95°.

"Remarks.—Under a strong lens the whole valve, except the beak, is found to be decussated or ornamented with a network of perforations, this being due to the exceptional development of the megalopores. The sutural laminae are much broken away, but the sinus was probably fairly broad and shallow. The insertion plates are quite missing—they have probably broken away. The most striking feature of this shell is the diagonal row of deep pits in the pleural area, and the much elevated broad diagonal rib of the lateral area.

"Locality.—Table Cape." [Tasmania.]

Age.—Miocene (Janjukian).

Note.—Thiele (Zoologica Revis. des Sys. der Chitonen, pt. ii., pp. 116-7) discards Pilsbry's two Sub-families, Callistoplacinae and Liolophurinae; he removes the two genera *Lorica* and *Loricella* from the Family Chitonidae, and places them next to the genus *Callistochiton*, under the Family Ischnochitonidae. He bases his views on the characters of the radula. I do not feel justified in following him in this, for the structure of the insertion plates, the peculiar tail valve and girdle characters of both these genera are extremely diverse from other members of the Ischnochitonidae. Until one has an opportunity of exhaustively studying the living animals, I prefer to follow Pilsbry in the retention of the two Sub-families Callistoplacinae and Liolophurinae.

Sub-family LIOLOPHURINAE, Pilsbry.

Genus *Lorica*, H. and A. Adams.

This genus, as stated above, was placed by Pilsbry under the Liolophurinae when he published his Monograph, 1892-3, when only a single species was recognised, *L. volvox*, Reeve, but since then *L. cimolea*, Reeve, has been recognised, and *L. haurakiensis*, Mestayer, from New Zealand, described. Three fossil forms have been described: *L. compressa* and *L. affinis* by Ashby and Torr, in 1901, and *L. duniana* by Hull, in 1910.

A careful examination of the living forms reveals the fact that the median valves in members of this genus show a great variation in both shape and sculpture in the same specimen, and a wide divergence in the adult from the juvenile form. It is, therefore, very difficult to determine whether individual valves show-

ing wide differences are deserving of specific rank, or are mere variations, sometimes in the same individual. Thus the shape and sculpture of valve 2 is always very different from that of the other median valves.

LORICA COMPRESSA, Ashby and Torr.

(Plate XIX., Figs. 22, 23, 24.)

(Trans. Roy. Soc. S. Austr., vol. xxv., pt. ii., pp. 136-7, pl. iv., fig. 6.)

Type Description.—"One example of median valve.

"General Appearance.—Strongly carinated, side slope straight, color yellowish to dark-brown. The valves are produced forward in an anterior beak.

"Lateral Area.—Much raised, ornamented with five, increasing to eight, at the insertion plates, granulose ridges. The granules near the girdle are arranged in transverse rows.

"Pleural Area.—This area is longitudinally ribbed with sixteen strong ridges, the interspaces are deep, the anterior portion is about the same width as the ridges, the posterior portion about double the width. There is a suggestion that the ridges were crossed by shallow transverse ridging.

"Dorsal Area.—This area is not separated from the pleural, the longitudinal ridging being continued right over the jugum.

"Measurement.—Greatest width between the slopes, 24 mm.; greatest width of slopes, 11 mm.; greatest length of slope, 18 mm. The longitudinal measurement of the dorsal area is 12 mm.; divergence, 85°. The insertion plates and sutural laminae are missing.

"Remarks.—This species differs from *Lorica volvox* and *L. affinis* in the strong radial ribbing of the lateral areas and the great number of the longitudinal ribs in the pleural area, but it corresponds with *L. affinis* in the compression of the side slopes. The decussation of the interspaces present in *L. affinis* is absent in this species."

Comments by Writer.—The depth of the interspaces between the longitudinal ribs in the median area is evidently due to erosion and the same factor accounts for the apparent great width of the ribs themselves, also in the lateral area the granules are almost worn down to the shallow radial ribs which they surmount.

Tail Valve.—This valve is laterally much less spread than is the case in the living form *cimolca*, the extremity of the tail is more elevated, the posterior margin more thickened, and whereas the granules on this valve are absent or subobsolete in the living form, in this species they are well defined, although limited to two or three rows corresponding to the lateral areas of the median valves.

This is the first record of the tail valve of this species, and was collected by Mr. Francis Cudmore, and by him deposited in the collection of the National Museum, Melbourne. Several median valves were also obtained, showing some variation, but all having extensive infolding of the tegmentum, below the beak, on the inside of the shell. It is now possible to figure the sutural laminae which were absent in the type.

Plesiotype in Nat. Mus. [13320], pres. F. A. Cudmore.

Locality.—Table Cape, Tasmania.

Age.—Miocene (Janjukian).

LORICA COMPRESSA, var. AFFINIS, (Ashby and Torr).

(Plate XX., Figs. 25, 26.)

(*Lorica affinis*, Ashby and Torr, l.c. p. 137, pl. iv., fig. 7, 1901; *Lorica duniana*, Hull, Proc. Linn. Soc. N.S.W., vol. xxxv., pt. 3, p. 654, 1910).

Type Description.—"One example of median valve.

"General Appearance.—Carinated, side slope slightly curved, though almost straight, color pale yellowish-brown.

"Lateral Area.—Distinctly raised, ornamented with six radial rows of somewhat distant pustules which rise out of very shallow ridges.

"Pleural Area.—Longitudinally ribbed with twelve narrow, but strong ridges; the interspaces are fully three times the width of the ribs, and nearly flat; these ridges have a slight tendency to granulation, but the transverse striae which produce the same appearance in its congener, *Lorica volvox*, are not discernible in this species. The megalopores are very pronounced, giving under a powerful lens a strongly decussated appearance.

"Measurement.—The greatest width between the slopes is 20 mm.; width of slopes, 10 mm.; length of slopes, 15 mm.; divergence, 90°.

"Insertion plates have broken away; there is no indication of teeth."

Hull, in his description of *L. duniana*, makes the following comments:—"This species is allied to *L. affinis*, Ashby and Torr, but is distinguishable from that species by the wider interspaces in the central area, and the larger pustules, and number of rows on the lateral areas."

I have no hesitation in considering *L. duniana*, Hull, identical with this form. The type (Pl. XX., Fig. 25) was an incomplete valve. This, together with the poor figure, no doubt accounts for Hull considering them distinct. If the missing portions of the sculpture of the median areas were restored, the number of longitudinal ribs would be the same as in Hull's figure of *duniana*. Similarly, if the missing posterior row of granules in the lateral area be restored, the radiating rows of granules would at the

outer margin also correspond. In this variety the dorsal ridge is straighter and the radial undulations in the lateral areas are less in evidence than is the case in *compressa* s.s., but the chief difference is in the greater width of the interspaces between the longitudinal ribs. The proportional spacing of the different species is much as follows:—

L. cimolea and *L. compressa* var. *affinis*, equally wide spacing.

L. compressa, sensu stricto, narrow spacing, about 25% more ribs.

L. volvox, much narrower, nearly double as many ribs as *cimolea*.

All, in some specimens, give some evidence of pectination, but *volvox* much more so; in some examples of *volvox* complete bridging is developed.

Locality.—Table Cape, Tasmania.

Age.—Miocene (Janjukian).

LORICA CUDMOREI, n. sp.

(Plate XX., Figs. 27a-c, 28.)

In the collection of the National Museum, Melbourne, and in his private collection, are altogether nine more or less perfect median valves collected by Mr. Francis A. Cudmore, which are consistently distinct from any described species; also among the specimens loaned to me by the widow of the late E. D. Atkinson are two similar valves. I have pleasure in naming this species after Mr. Cudmore.

Median Valves.—All the median valves examined are much arched longitudinally from the beak forward, in this respect being very different from either *cimolea* or *compressa*, except in valve 2, which in *cimolea* is arched, though to a much less degree; it is not likely that all the valves under consideration are each the second valve, so we may conclude that in the living shell valves 2 to 7 are all very much arched longitudinally. All the valves are strongly carinated, the angle of divergence being considerably less than *cimolea*. The sinus between the sutural laminae appears wide in several specimens, and in the one I have chosen as type, but this appearance may be due to breaking away; of this I cannot be certain. Insertion plates present, slits 1/1, insertion propped and deeply grooved on the upper side. The longitudinal sculpture of the dorsal area consists of rapidly diverging ribs. I count ten at the anterior margin, thus making the area broadly wedge shaped. The longitudinal ribs in the pleural area are in the upper two-thirds of valve bent down anteriorly, almost running into one another, and thereby making room for the broad dorsal area. This feature is more marked than in any other form. All valves are much compressed laterally. The ribs nearest to the dorsal area are pectinated, becoming less so in the outer ribs, which are also more widely spaced. The lateral area is strongly raised and decorated

with five complete radial rows, of widely-spaced, finger-like grains. These rows are intercalated, making the total number of rows, including the outer ones, ten. The infold of the tegmentum under the beak is much narrower than in *L. compressa*. The median valve has a well defined row of closely packed cavities or large pores (I counted over 30 holes which were probably the terminals of the megal aesthetes, and may or may not have been transformed into "eyes"). In the living forms of members of this genus, these apertures are usually obsolete or sub-obsolete; this row of pores is situated on the unsculptured slope which divides the lateral area from the pleural. In the upper half of the shell the longitudinal ribs have on the lower side a number of similar pores, which contribute to the pectinated appearance.

Measurements.—11.5 mm. longitudinally, by 18 mm. laterally.

Holotype in National Museum, Melbourne [13321], pres. F. A. Cudmore.

Locality.—Table Cape beds, Tasmania.

Age.—Miocene (Janjukian).

Anterior Valve.—I am associating with the above an anterior valve which was also collected by Mr. Cudmore at the same locality. Strongly elevated, laterally compressed, apex recurved, making the anterior slope concave, decorated with 29 radial rows of spaced, raised, circular grains. The posterior margin is edged with a row of coarse grains that give it a toothed appearance, the tegmentum is folded over to the inside throughout the whole length of the posterior margin and under the apex is broadly so, and there coarsely, longitudinally ribbed.

Nat. Mus. [13322], pres. F. A. Cudmore.

Measurements.—6 mm. longitudinally, 9.5 laterally, elevation 4.5 mm.

Protolorica, n. gen.

Tail valve without anal sinus, and posterior extremity not upturned, having numerous pores or eyes on the inner margin of the lateral area, and immediately below the longitudinal ribbing of the pleural area. Type of genus, tail valve described below under the name *Protolorica atkinsoni*, Ashby.

PROTOLORICA ATKINSONI, n. sp.

(Plate XX., Figs 29a,b.)

Among the specimens loaned to me by Mrs. Atkinson is a tail valve that was taken by her late husband at Table Cape. The entirely different structure of this valve from that of the true Loricas, makes it necessary to provide a new genus for its reception. I consider it a primitive form through which the genus *Lorica* has been derived. When the description of *Lorica cudmorei*, Ashby, was written, the writer had not seen this tail valve, and at first, on receiving it from Mrs. Atkinson, intended associat-

ing it with that species, but on second thoughts concluded to make this valve the type of the new genus and attach to it a distinctive name, until such time as the production of new material may otherwise determine. We do not for certain know that this valve belongs to the same horizon as the median valves collected by Mr. Cudmore, which are described above. If in the future similar tail valves are met with in the same bed as *L. cudmorei*, then that species must be transferred to this genus, and *Protolorica atkinsoni* will be a synonym of *Protolorica cudmorei*.

Tail Valve.—Dorsal area eroded, pleural area is ornamented with 8 longitudinal ribs, all of which are furnished with a series of pores similar to those described in the median valves of *L. cudmorei*. A row of similar pores commencing at the mucro and extending to the outer margin, separates the lateral area from the pleural.

Mucro at the posterior margin, but not upturned, and posterior sinus absent. The lateral area is well defined, raised and decorated with radiating rows of rounded, elevated granules, commencing in three rows and a fourth being intercalated half way down the valve. Sutural laminae shallow, sinus narrow. The tegmentum is widely folded over at the mucro, the inside of the fold being longitudinally ribbed.

Measurements.—8.5 mm. longitudinally, 11.5 mm. laterally.

Locality.—Table Cape, Tasmania.

Age.—Miocene (Janjukian).

Genus *Loricella*, Pilsbry.

Sinus in tail valve a mere wave; jugal sinus lobed; girdle widest in front, not cleft behind. Ashby (Pap. and Proc. Roy. Soc. Tas. 1921, p. 39, pl. xv., fig. 4) describes and figures what he terms a "spade-like process," which is formed in the sinus, between the sutural laminae, by a forward extension of the articulamentum. This process is in the living forms slit on either side, to the tegmentum, and seems to be an important character of this genus.

LORICELLA GIGANTEA, Ashby and Torr.

(Plate XXI., Figs. 30, 31.)

(Trans. Roy. Soc. S. Austr., vol. xxv., pt. ii., pp. 137-138, pl. iv., fig. 3, 1901; *Loricella magnifica*, Hull, median valve, Proc. Linn. Soc. N.S.W., vol. xxxix., pt. 4, p. 856, 1915.)

Type Description.—"One specimen of anterior valve only.

"General Appearance.—Color dirty-white or wainscot-brown, shape exceptionally broad (nearly twice as broad as long), and very flat, anterior third of valve curved downwards, other two-thirds practically straight except at the apex, which is very slightly elevated.

“Sculpture.—Radially ribbed with very numerous, pronounced, bifurcating riblets, which are crossed by about 26 concentric wrinkles; while these are clearly defined, some are more so than others. These wrinkles break up the riblets into more or less pronounced granules. The eves [*sic*] only slightly overhang. Slits 18, at irregular distances. Margins of teeth are irregular, more crenulate than pectinate. The strong pectination of its congener, *Loricella Angasi*, Ad. and Ang., is quite absent, but the teeth are deeply grooved to their bases, very little indication of this being present in the living form. In *L. Angasi* a deep groove runs from each slit to the apex. In the fossil under review there is no groove, but its place is occupied by a slightly raised rib.

“Inside of Shell (Articulamentum).—The valve, except where stained, is paler than the tegmentum, a rib running from each of the slits to the apex, except that from the posterior slit, which is almost parallel with the posterior margin of valve.

“Measurement.—Length, 16 mm.; breadth, 33 mm.; elevation, $7\frac{1}{2}$ mm.

“Locality.—Mornington. [?].

“Remarks.—As compared with *Loricella Angasi*, the valve is much flatter, is convex instead of concave. The coarse radial ribs, nine or more in number, present in *L. Angasi*, are entirely absent, the riblets being evenly distributed over the whole valve. The largest specimen of *L. Angasi* known to us measures 68 mm. by 44 mm. This valve is fully one-fourth larger than the anterior valve of that specimen, and therefore we may conclude that when living this ancient form would have measured fully 85 mm. by 55 mm.”

Median Valve.—This valve was described by Hull as *Loricella magnifica*, and associated with an anterior valve (l.c.); the sculpture exactly corresponds with the type valve of *L. gigantea*, Ashby and Torr, and this, taken in conjunction with the exceptionally low elevation of both valves, determines one to consider them conspecific.

I quote Hull's description of the sculpture with interpolations of my own. “Median valve: lateral areas strongly raised, irregularly sculptured with wavy lines [riblets]; central areas with similar but shallower lines, crossed by numerous faint grooves [or lines of growth].”

Measurement.—38 mm. laterally, where sutural laminae are complete; longitudinally, 10 mm.; elevation, 11 mm.

The anterior edge of the sutural lobe is worn and weathered, but there remains a notch on either side, which I believe are the bases of the slits on either side of the spade-like process.

Locality.—Table Cape, Tasmania.

Age.—Miocene (Janjukian).

Note.—The locality of Ashby and Torr's type is given as “Mornington.” This is probably an error; it is much more likely that it came from Table Cape, in Tasmania, as there are fossils

from that locality in the same containing box. There is no original locality label, but a reference No. "18," is attached to the shell. This may have had reference to some catalogue of either Tate or Dennant. Hull (l.c.) omitted to signify which of the two valves he described under the name *Loricella magnifica* was his type. The anterior valve is too worn for determination, but obviously belongs to an elevated form, whereas the median valve well shows the sculpture in parts, and belongs to a species of exceptionally low elevation. I, therefore, designate Hull's median valve as his type, and consider it conspecific with *L. gigantea*, Ashby and Torr.

LORICELLA PAUCIPUSTOLOSA, (Ashby and Torr).

(Plate XXI., Figs. 32, 33; Pl. XXII., Figs. 34, 35, 36.)

(*Chiton paucipustulosus*, Ashby and Torr, Trans. Roy. Soc. S. Austr., vol. xxv., pt. ii., p. 141, pl. iv., fig. 2, 1901; *Loricella atkinsoni*, Hull, Proc. Linn. Soc. N.S.W., vol. xxxix., pt. 4, pp. 856-857, 1915; *Loricella octoradiata*, Hull, l.c.; *Loricella magnifica*, Hull, l.c., anterior valve only).

Type Description.—"One median valve from Table Cape. A well-preserved specimen.

"The Lateral Area is slightly raised, and contains a number of wavy transverse sulcations, or growth lines, extending into the pleural area. There are 12 to 14 small pustules on the anterior margin of the lateral area.

"Pleural Area.—The growth lines are very distinct in this area, and extend across the jugum. There are about 12 short longitudinal imbricating riblets, those nearest the jugum being the longest, and becoming shorter as they approach the centre of slope, those near the centre being mere elongated lumps. From the centre to the girdle they are absent.

"Length of dorsal area, 6 mm. Sinus wide, increasing from 2 to 4 mm. The sutural laminae are 3 mm., wide near the sinus, gradually lessening towards the girdle. The pectination of the teeth is fairly distinct.

"Measurement.—Width, 25 mm.; length of area, 6 mm.; divergence, 105°."

Hull was certainly correct in placing his *L. atkinsoni* under the genus *Loricella*. Ashby and Torr, when they described *paucipustulosus*, had only a median valve, whereas Hull had both anterior and median valves. Hull did not indicate which of these valves was his type. I therefore designate the median valve as his type of his *Loricella atkinsoni*, Hull, which name will stand as a synonym of *L. paucipustulosa*.

Median Valve.—Hull's type is now before me, and is obviously conspecific with Ashby and Torr's *paucipustulosus*; in Hull's type the marginal row of pustules is a little more clearly defined, and

the two rows surmount definitely raised ribs, but in his specimen the lateral area between the pair of radiating ribs appears concave, but is really of the same level as the rest of the valve; in all other respects it corresponds with the type valve of *paucipustulosus*; insertion plate and eaves well defined, slits 1/1, spade-like process in the jugal sinus well defined, as shown in Ashby and Torr's figure of their type.

Measurement.—Laterally, 22.5 mm.; longitudinally, 7 mm.

Anterior Valve.—Hull quite correctly associated the beautifully preserved anterior valve which he described under the name of *L. atkinsoni*, with his type of the median valve described under the same name. It is decorated with 10 evenly spaced, shallow radial ribs, two of which are close to the posterior margin, the other eight correspond with the slits. Each rib is surmounted by a single row of widely spaced, rounded granules, in all respects similar to the 2/2 rows present in the median valves. As pointed out by Hull, "the anterior third of slope [slightly] convex," from there to the apex the slope is steeper. There are a few granules in addition to those in the rows, close to the anterior margin.

Measurements.—Longitudinally, 12.5 mm.; laterally, 20 mm.; elevation at apex, 6 mm.

Loricella octoradiata, Hull (Proc. Linn. Soc. N.S.W., vol. xxxix., pt. 4, p. 856, 1915). The type valve is now before me, and measures laterally 22 mm. and 7.5 mm. elevation to the apex, the posterior margin is everywhere incomplete, so the longitudinal measurement cannot be given. In this single valve, upon which Hull founded his species, the whole of the tegmentum or upper shell has flaked off (with the possible exception of a fragment at one of the wings). None of the original sculpture is in existence; the radial markings described as ribs are the bases above which, in the living shell, the ribs had once been formed, but with the destruction of the tegmentum had entirely disappeared.

These bases are defined by a double row of pores, the shell structure between the rows being apparently different from that of the rest of the shell; in Hull's description they are spoken of as "prominent ribs," but as a matter of fact they are throughout most of their length, flat. Hull states that "the interspaces very finely sculptured with irregular V-shaped lines," he also shows these lines in his figure (l.c., pl. xciv., fig. 2); they are not sculpture as he supposes, but due to the structure of the interior layers of shell. The "V-shaped lines" evidently are channels for nerve fibres which after passing through the pores, margining the so-called ribs, branch off in fine bow-shaped grooves, terminating or dying away in the centre of the interspaces; a corresponding series of nerve-fibre channels branch off from the corresponding row of pores on the other side of the interspace; the double series of bent fibre channels, meeting along the central line, gives the V-shaped appearance mentioned by Hull as sculpture. The valve has eight slits corresponding with the "rib-bases" before

described, the slits seemingly having some relation with the system of distribution of the nerve fibres.

The shape of the valve, the number and position of the slits and corresponding rib-bases, entirely accord with the anterior valve of *Loricella paucipustulosa*, Ashby and Torr, with which species I consider it conspecific; therefore *L. octoradiata*, Hull, is a synonym of that species.

Loricella magnifica, Hull (l.c., p. 856, pl. xciv., fig. 1, anterior valve only.) As stated earlier, I consider that the anterior valve described by Hull under this name (which valve is now before me) is not conspecific with the median valve described by him at the same time under the same name. This anterior valve is very much worn, the whole of the sculpture having been eroded. Some of the slits are in evidence, the remaining indications suggest the number to have been 8, the number of ribs cannot be determined but was probably 10, of which 8 would correspond with the slits and the other two marginal ones. The shell is more elevated than either of the other two anterior valves of *paucipustulosa*, referred to above, but as the shell is larger than either, measuring longitudinally 15 mm., laterally 26 mm., and elevation, 11 mm., it seems likely that, while quite juvenile *paucipustulosus* may be flat, the elevation increases considerably with age. The subsidiary riblets referred to in Hull's description may not unlikely have been subcutaneous, as the upper layer of shell is absent. In the anterior valve of *paucipustulosa*, described above, there is a suggestion of very shallow intercalated riblets, but these certainly have no relation to the slits.

The very imperfect condition of this valve prevents accurate determination, but I have noticed no feature that warrants its separation from *Loricella paucipustulosa*, Ashby and Torr.

In conclusion,—This species is allied to the living form *Loricella torri*, Ashby, in that the anterior valve is furnished with 8 slits with corresponding shallow ribs surmounted with single rows of widely spaced, circular granules. I have one specimen from Port Jackson, measuring 5 mm., laterally, in the anterior valve, in which these ribs are almost identical with the fossil under discussion, and in this specimen the interspaces approach the fossil in smoothness, but the living form is certainly very variable, for in many specimens there are numerous intercalating riblets. In the median valves the living form differs widely, for longitudinal ribbing is always present, but absent in the fossil. Both the living forms, *L. angasi*, Ad. and Ang., and *L. torri*, Ashby, have 8 slits and the spade-like process in the jugal suture of the median valves in common with the fossil.

Locality.—Table Cape, Tasmania.

Age.—Miocene (Janjukian).

Pseudoloricella, n. sub-gen.

Chitons in which the median valves are strongly sculptured, in general form corresponding with members of the genus *Loricella*

except for the fact that the sutural laminae are joined across the median line, the "spade-like process" occurring in the jugal sinus of the genus *Loricella* being absent.

LORICELLA (PSEUDOLORICELLA) SCULPTA, Ashby.

(Plate XXII., Figs. 37a,b.)

(*Loricella sculpta*, Ashby, Pap. and Proc. Roy. Soc. Tas., 1921, pp. 37-40, pl. xv., figs. 1-2.)

Introduction.—On page 39 (l.c.) in discussing the "spade-like process" which is present in the living forms of *Loricella*, occurs the following sentence: "The sinus or space separating the sutural laminae in the median valves (of *L. angasi* and *torri*), is very broad, with a deep slit at each side, this slit penetrating to the tegmentum, having a 'spade-like process' with a denticulate margin between the two slits."

"This feature is present in both the two living species, but in the fossil one under review these slits are entirely absent or rudimentary. It suggests that this feature may have been developed in recent times, in which case the fossil *Loricella* might very properly receive sub-generic distinction." Having now had the opportunity of examining all the types of fossils described as belonging to the genus *Loricella*, I have no hesitation in carrying out my earlier suggestion of providing a sub-genus for the reception of this species. *L. angasi*, *torri* and *paucipustulosa*, all have the spade-like process, and the anterior valve of each is furnished with 8 slits, but *L. gigantea*, Ashby and Torr, has a multi-fissate anterior valve, and although the unique median valve is too imperfect for accurate determination, it was, I think, furnished with the spade-like process, and therefore a true *Loricella*. The species described by the writer under the name *Loricella sculpta*, in addition to the absence of this feature, may, when the end valves are discovered, be found to possess other distinguishing characters.

Type Description.—"Up to the present one median valve only has been discovered in the Table Cape Beds, but it is in an excellent state of preservation; its beautiful sculpture, which suggests the name I am giving it, is as perfect as it was during life. The shell is remarkably flat, although carinated.

"Pleural and Dorsal Areas.—These are evenly decorated with narrow, strongly raised, wavy ribs; these in places are bridged by transverse ribs following the growth lines. These are particularly marked towards the anterior margin, where the transverse ribs resemble a string of small beads. Towards the posterior portion of the valve this feature of the sculpture is somewhat modified, and might be more correctly described as a series of irregularly and widely spaced grooves, following the growth lines and breaking to some extent the longitudinal ribs where they cross. These longitudinal ribs are more or less confluent on the jugum, and to a limited extent in the pleural area.

“Lateral Area.—This area is much raised and strongly decorated with coarse, radiating, wavy ribs; these are broken at irregular intervals by deep grooves, which are a continuation of the growth lines which cross the pleural area, and turn abruptly at less than a right-angle across the lateral areas.

“Inside.—Eaves well developed, insertion plates 1 slit, evidences of not very pronounced serrations. The sutural laminae are well developed, and appear to be much less produced forward than is the case with *L. angasi*, Ad. and Ang. [appearance due to the almost entire absence of sinus], the anterior margin throughout being almost straight, but in places it is a little broken; therefore, in a perfect shell, this feature may be less pronounced. The suture is broad, and the slits on either side thereof are absent. The anterior margin of the callus portion is almost straight, and the thickening very pronounced. The tegmentum is folded over the posterior margin in a similar manner to both *L. angasi*, Ad. and Ang., and *L. torri*, Ashby, with this difference, that in the fossil the margin is almost straight, whereas in the two species referred to, it curves outwards under the jugum, in a semi-circle.

“Note.—The strength and character of the sculpture easily separate this species from any other of the known fossil *Loricella*.”

Locality.—Table Cape, Tasmania.

Age.—Miocene (Janjukian).

In Ashby and Torr's paper (l.c., pp. 142-4, 1901), several examples of fossil Chitons were described under generic names only, “sp.indet.”; it seems desirable to refer to these, all of which have been placed in my hands for examination; each of these forms is designated in their paper under a number, which I now quote.

- No. 10.—“*Lepidopleurus* sp.indet.” This is described in this paper under the name *Lepidopleurus magnogranifer*, Ashby.
- No. 11.—“*Ischnochiton* sp.indet.” All six median valves are fragments of *Protochiton granulosus*, Ashby and Torr.
- No. 12.—“*Chiton* sp.indet.” Genus uncertain, possibly a *Lorica*.
- No. 13.—“*Ischnochiton* sp.indet.” Not *Ischnochiton*, possibly *Loricella paucipustulosa*, Ashby and Torr.
- Nos. 14, 15 and 16—“*Chiton* sp.indet.” Genus quite uncertain.
- No. 17.—“*Lorica* sp.indet.” Genus correct; sp.indet.
- No. 18.—“*Acanthochiton* sp.indet.” Is *Afossochiton cudmorei*, Ashby.
- No. 19.—“—————.” One specimen is a fragment of “*Protochiton granulosus*, the rest indet.

AUSTRALIAN FOSSIL PLACOPHORA.

Class AMPHINEURA.

Order POLYPLACOPHORA, Blainville.

Suborder EOPLACOPHORA, Pilsbry, 1900.

Family GRYPHOCHITONIDAE, Pilsbry, 1900.
(Palaeozoic forms; no Australian example yet found.)

Family LEPIDOPLEURIDAE, Pilsbry, 1892.

Genus *Lepidopleurus*, Risso, 1826.

LEPIDOPLEURUS MAGNOGRANIFER, Ashby, n. sp.

Family PROTOCHITONIDAE, Ashby, n. fam.

Genus *Protochiton*, Ashby, n. gen.

PROTOCHITON GRANULOSUS (Ashby and Torr, 1901).

=*Acanthochites granulatus*, Ashby and Torr, 1901.

Syn. *Ischnochiton (Ischnoplax) granulatus* of Chapman.

Suborder CHITONINA, Thiele, 1910.

Family ACANTHOCHITONIDAE, Hedley, 1916.

Subfamily AFOSSOCHITONINAE, Ashby, n. subfam.

Genus *Afossochiton*, Ashby, n. gen.

AFOSSOCHITON CUDMOREI, Ashby, n. sp.

A. ROSTRATUS, (Ashby and Torr, 1901).

=*Acanthochiton rostratus*, Ashby and Torr, 1901.

Subfamily ACANTHOCHITONINAE, Ashby, 1925.

Genus *Acanthochiton*, Gray, 1821, em.

ACANTHOCHITON CHAPMANI, Ashby, n. sp.

Subfamily CRYPTOPLACINAE, Thiele, 1910.

Genus *Cryptoplax*, Blainville, 1818.

CRYPTOPLAX PRITCHARDI, Hall, 1905.

C. GATLIFFI, Hall, 1905.

Family MOPALIIDAE, Pilsbry, 1892.

Genus *Plaxiphora*, Gray, 1847.

PLAXIPHORA CONCENTRICA, Ashby and Torr, 1901.

[*P. gellibrandi*, Ashby and Torr, 1901=*P. albida*, Bl., recent.]

Family ISCHNOCHITONIDAE, Pilsbry, 1892.

Subfamily CALLISTOPLACINAE, Pilsbry, 1892.

Genus *Callistochiton*, Carpenter, 1882.

CALLISTOCHITON MERIDIONALIS, Ashby, 1919.

Family CHITONIDAE, Pilsbry, 1892.

Subfamily CHITONINAE, Pilsbry, 1892.

Genus *Chiton*, Linné, 1758.

Subgenus *Rhyssoplax*, Thiele, 1893.

CHITON (*RHYSSOPLAX*) FOSSICIUS, Ashby and Torr, 1901.

Subfamily LIOLOPHURINAE, Pilsbry, 1893.

Genus *Lorica*, H. and A. Adams, 1852.

LORICA COMPRESSA, Ashby and Torr, 1901.

L. COMPRESSA, var. *AFFINIS* (Ashby and Torr, 1901).

=*L. affinis*, Ashby and Torr, 1901.

Syn. *L. duniana*, Hull, 1910.

L. CUDMOREI, Ashby, n. sp.

Genus *Protolorica*, Ashby, n. gen.

PROTOLORICA ATKINSONI, Ashby, n. sp.

Genus *Loricella*, Pilsbry, 1893.

LORICELLA GIGANTEA, Ashby and Torr, 1901.

Syn. *Loricella magnifica* (median valve only), Hull, 1914.

L. PAUCIPUSTULOSA (Ashby and Torr, 1901).

=*Chiton paucipustulosus*, Ashby and Torr, 1901.

Syn. *Loricella atkinsoni*, Hull, 1914.

Syn. *L. octoradiata*, Hull, 1914.

Syn. *L. magnifica* (anterior valve only), Hull, 1914.

Subgenus *Pseudoloricella*, Ashby, n. subgen.

LORICELLA (PSEUDOLORICELLA) SCULPTA, Ashby, 1921.

=*Loricella sculpta*, Ashby, 1921.

Note on Suborders and Superfamilies.—Pilsbry (Man. Conch., 1892), used three Superfamily names—(1) Eoplacophora, (2) Mesoplacophora, (3) Teleoplacophora; considering all Palaeozoic Chitons to belong to his family Lepidopleuridae. But in Zittel (l.c., 1900), he uses his name Eoplacophora as a subordinal name, with a new family which he calls Gryphochitonidae, to include all Palaeozoic species. Thiele (l.c., 1910), uses two subordinal names



